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RIB VARIATION IN CARDIUM.

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CONTENTS.

I. Introduction. II. Material. III. Method of obtaining quantitative data. IV. Discussion of data. *Cardium robustum*. *Cardium isocardia*. *Cardium muricatum*. V. Comparison of the three species.

I. INTRODUCTION.

AT the present time biologists and zoölogists are paying marked attention to the study of the laws of variation, such studies having a strong bearing upon the origin of species. The results of such studies will be of little value, however, unless great care is taken in recording the exact locality from which the material came. And likewise the results will be *nil* unless the material studied is of such a quantity as to form a good basis for a quantitative examination. It frequently happens that a careful study of the variation of a certain species is rendered valueless because the working material has been too limited in quantity.

That the time expended in such study is well spent is clearly shown by the following statement made by the late Prof. Edward D. Cope.[1]

"So soon as sufficient material becomes available, the zoölogist can make that kind of research into the permanency and variability of the characters of species which characterizes the exact stage of the science. It is on such study that all useful conclusions as to the origin of species depends. It is not the orderly relation of species and genera to each other that demonstrates the truth of the hypothesis of the derivation of the species, but the knowledge of their variations. Moreover, the beginning of all investigation into the causes of those variations is the knowledge of the direction which they take, whether they are promiscuous or whether they bear some definite relation to each other or to the environment."

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[1] As quoted by C. C. Adams, p. 208.

The following paper is a contribution to the study of variation in the sculpture of the pelecypod Mollusca, as shown in the genus Cardium.

II. MATERIAL.

The material upon which this paper is based consists of three species of Cardium; *C. robustum*, *C. isocardia*, and *C. muricatum*. They were collected by Dr. J. W. Velie and W. W. Calkins on the west coast of Florida, near Tampa. Several hundred specimens of each species have been examined, thus affording enough material for a wide range of variation. To this material is added some data gathered by Dr. W. H. Dall and published in his "Contributions to the Tertiary Fauna of Florida."

III. METHOD OF OBTAINING QUANTITATIVE DATA.

The ribs on each valve were carefully counted and in order to remove any possibility of error they were recounted several times at intervals of two or three days. The size (length) of each shell was determined by a pair of calipers spread from the umbones to the ventral margin. These measurements are all in millimeters.

In the curves plotted, the groups or classes having the same number of ribs are indicated on the horizontal line, and the number of specimens in these groups, the frequencies, are noted on the vertical line.

In the tables the number of ribs is indicated as a numerator, and the individuals having the same number of ribs is noted as a denominator.

IV. Discussion of Data.

Cardium robustum. (= magnum.)

Figures 1 and 2.

Table A.

30	31	32	33	34	35	36	37
1	33	77	128	81	39	3	2

Number of shells examined 364. The range of variation is from 30 to 37.

The mode, or class with the largest number of individuals, is 33, with a frequency of 128. This curve is remarkable for its regularity and for its strong monomodal tendency.

In counting the ribs of this, as well as of other species, it was noted that the variation was confined almost wholly to that part of the shell anterior or in front of the umbonal ridge, the latter being strongly indicated by a large, heavy rib extending from the umbones to the ventral margin, and separating the flat posterior slope from the rounded anterior and lateral slopes.

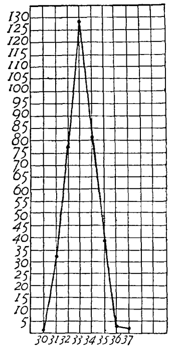

Fig. 1. *Cardium robustum.* Variation curve of 364 specimens.

There is one more rib on one valve than on the other in this region, the numbers being 7–8, or 8–9. The ribs of this area were carefully counted and the following result obtained, the figures being for the maximum number of ribs: $\frac{7–8}{355}$. $\frac{8–9}{9}$. This gives the normal or mode at 7–8, with a frequency of 355. If this were plotted on a diagram it would give a very sharp, narrow curve, which always stands for stability. It is also noteworthy that the curve for all the ribs and that for the ribs posterior to the umbonal ridge are similar in form. The size of the shell apparently does not change the result of these calculations. 41 specimens measuring 90 millimeters gave the result shown in figure 2 and in the following table:

Table B.

31	32	33	34	35	36
1	14	15	8	2	1

As in table A the mode is at 33 (frequency 15) with an additional minor mode at 32 (frequency 14). This indicates a larger amount of variation for the 90 millimeter individuals than for the whole number of specimens, and illustrates the value of examining a large amount of material in order that a false impression may not be given by the curve.

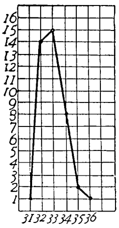

Fig. 2. *Cardium robustum.* Curve of 41 specimens, 90 millimeters long.

Dall[1] has examined a number of specimens of this species and the results are interesting. He found the range of variation to be from 30 to 35, forty-five specimens being counted. Dall remarks that there is a slight tendency to fewer ribs in the southern than in the northern individuals of this species. It would be interesting to have a large number of specimens from different localities examined and plotted, to ascertain the exact amount of this variation.

Cardium isocardia.

Figures 3 and 4.

Table C.

27	28	29	30	31	32	33	34	35	36
3	12	22	73	70	24	13	3	1	1

Number of shells examined 222. The range of variation is from 27 to 36. The mode is at 30 with a frequency of 33 and a minor mode at 31 with a frequency of 70. The noteworthy feature of the curve of *isocardia* is the polygonal instead of the triangular form and the marked symmetry of the two sides.

A comparison of the curves obtained from an examination of different sized shells is interesting, and is shown in figure 4 and the following table:

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[1] Dall, W. H. Contributions to The Tertiary Fauna of Florida. *Trans. Wagner Inst. Sci.*, Vol. III, part V, p. 1099.

Table D.

Size in millimeters.	28	29	30	31	32	33	34	35
30.		4	12	6	4	3	1	1
40.	6	3	16	16	5	3		
50.			5	14	4	4		

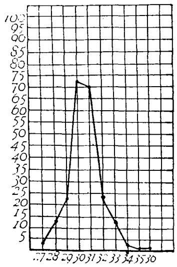

Fig. 3. *Cardium isocardia.* Variation curve of 222 specimens.

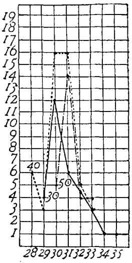

Fig. 4. *Cardium isocardia.* Variation curve of size.

The number of shells examined of the 30 mill. individuals was 31. The range of variation is from 29 to 35, with a mode at 30 and a frequency of 12. Of the 40 mill. individuals 49 species were examined. The range is from 28 to 33, with a double mode at 30 and 31 and a double frequency of 16. The 50 mill. individuals included 27 specimens. The range is from 30 to 33, with a strong mode at 14. The range of variation in the 30 and 50 mill. specimens is very uniform and the curves are almost identical. In the 40 mill. individuals there is more variation as shown by the broadness of the curve and its irregularity at the lower part. This wider range of variation may account in a measure for the polygonal form of the curve for the total number of specimens.

The ribs of *isocardia* are much crowded on the anterior and posterior slopes of the shell, where, also, the greatest spinosity exists.

Cardium muricatum.

Figure 5.

Table E.

29	30	31	32	33	34	35	36	37	38	39
2	6	31	27	25	10	5	2			2

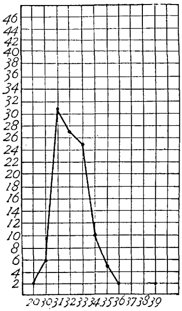

FIG. 5. *Cardium muricatum.* Curve of 110 specimens.

Number of shells examined 110. The range of variation is from 29 to 39, with a break between 36 and 39. The mode is at 31 with a frequency of 31, a strong minor mode at 32, with a frequency of 27 and a weaker minor mode at 33, with a frequency of 25. The width of this curve shows a considerable amount of variation. As in *isocardia*, the ribs are crowded at the anterior and posterior ends and the side ribs are frequently quite smooth.

Dall (*loc. cit.*, p. 1090) has examined 55 individuals of this species, gathered from all parts of its habitat, and the result is as follows :

Figure 6.

Table F.

30	31	32	33	34	35	36	37	38	39	40	41
2	9	5	8	7	8	6	5		3	1	1

A comparison of the two figures is interesting. The mode of curve No. 6 is at 31 with a frequency of 9 and two minor modes at 33 (frequency 8) and 35 (frequency 8). The breadth of this curve and its multimodal form shows a greater amount of variation in its entire range than do the specimens from near Tampa, in which the number of the ribs is more stable. The major mode, however, remains the same, showing that the normal number of ribs for this species is 31.

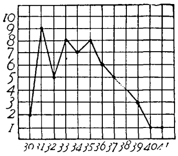

FIG. 6. *Cardium muricatum.* Curve of 55 specimens, selected from its entire range. (Dall.)

Dall makes the following remarks concerning the rib variation of *muricatum*. "The only generalization that seemed authorized is that the ribs are less numerous in specimens from near the northern border of the range of the species, and also in the fossils; the specimens with 37 to 41 ribs are nearly all from the southern half of the area inhabited. There was no diminution of ribs towards the southern extreme of the range and no regularity in the variations of the murication which could be correlated with difference of habitat."

Here again it would be interesting to know the results obtained by a quantitative study of a large amount of material from different localities.

V. Comparison of the Three Species.

Figure 7.

A comparison of the three species shows that *magnum* is the least variable, while *muricatum* is the most variable, as is shown by the width of the curve. *C. isocardia* seems to stand midway between these two species.

In the study of quantitative variation in the Mollusca the fact presents itself that in each species there is a mode or constant which remains unvaried and from which certain individuals vary sporadically. These would seem to be brought about by accidental variation rather than by natural selection.

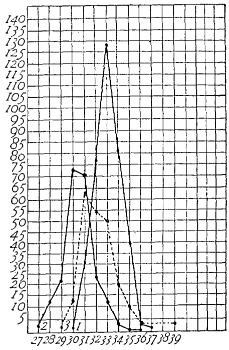

Fig. 7. Comparison of the three species. 1, *robustum*. 2, *isocardia*. 3, *muricatum*. (Classes doubled.)

In figure 7 it will be seen that each species has a particular and different constant. *C. magnum* (1) has 33 as a constant and shows a minimum of variation: *isocardia* (2) has 30 as a constant and *muricatum* (3) has 31 as a constant, but shows a large amount of variation.

It is evident from the above study that the number of ribs is not a safe character upon which to found a species. A small number of specimens, 20 or 30, might show an apparent break in the numerical variation and seem to warrant the separation of some individuals as species, but a larger number of specimens shows that the number of ribs cannot be used in the separation of species without other more important characters.

It would be interesting to know the results obtained by an examination of a large number of specimens from different localities, to ascertain the stability of the data recorded in this paper.

My thanks are due to Professor C. B. Davenport of the University of Chicago for valuable suggestions in carrying on this study.

CHICAGO, ILL.